**NATURAL RESOURCES CONSERVATION SERVICE**
**CONSERVATION PRACTICE STANDARD**

# IRRIGATION WATER CONVEYANCE NONREINFORCED CONCRETE PIPELINE

**(Ft.)**
**CODE 430CC**

## DEFINITION

A pipeline and appurtenances installed in an irrigation system.

## PURPOSE

To prevent erosion, degradation of water quality, or damage to the land; to make possible the proper management of irrigation water; and to reduce water conveyance losses.

## CONDITIONS WHERE PRACTICE APPLIES

This standard applies to low or intermediate pressure, nonreinforced concrete irrigation pipelines with rubber gasket joints, mortar joints, or cast-in-place without joints.

All pipelines shall be planned and located to serve as integral parts of an irrigation water distribution or conveyance system designed to facilitate the conservation use and management of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries to the area shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used. Concrete pipelines shall not be installed on sites where the sulfate-salt concentration in the soil or soil water exceeds 1.0 percent. On sites where the sulfate concentration is more than 0.1 percent but not more than 1.0 percent, concrete pipe may be used only if the pipe is made with Type V cement or Type II cement whose tricalcium aluminate content dose not exceed 5.5 percent.

## CRITERIA

**Working pressure.** The pipelines shall be designed to meet all service requirements without a static or working pressure, including hydraulic transients, at any point greater than the minimum allowable working pressure of the pipe used at that point. The static or working pressure of pipelines open to the atmosphere shall include freeboard.

The maximum working pressure for rubber gasket joints shall not be more than one-third of the certified hydrostatic test pressure determined by the test procedure in ASTM C 505. The design working pressure shall not exceed 30 feet for 6 through 24 inch diameter and 25 feet for 26 through 36 inch unless a written certification report is obtained from the supplier certifying that the higher hydrostatic test pressures per ASTM C 505 were used in which case the design working pressure shall not exceed 50 feet of head for sizes 6 through 12 inch diameter, 40 feet for sizes 15 through 18 inch, 30 feet for sizes 21 and 24 inch, and 25 feet for sizes 26 through 30 inch.

The maximum working pressure for mortar joints shall not be more than one-fourth the certified hydrostatic test pressure as determined by the hydrostatic test pressure prescribed in ASTM C 118. The design working pressure shall not exceed 30 feet for 6 through 10 inch diameter and 26 feet for 12 through 18 inch and 23 feet for 20 through 24 inch unless a written certification report is obtained from the supplier certifying that the higher hydrostatic test heads per ASTM C 118 were used in which case the design working pressure shall not exceed and shall not exceed 40 feet of head for sizes 6 and 8 inch diameter, 35 feet for sizes 10 and 12 inch, 30 feet for sizes 14 through 24 inch, and 25 feet for sizes 26 through 30 inch.

**External load limit.** A safety factor of at least 1.25 shall be applied to the three-edge bearing test in computing allowable heights of fill over the concrete pipe.

**Friction losses.** For design purposes, friction head losses shall be no less than those computed by Manning's formula, using a coefficient of roughness "n" of 0.011 for rubber-

gasket-jointed pipe, 0.012 for mortar-jointed pipe.

**Capacity.** The design capacity of the pipelines shall be based on whichever of the following criteria required the larger amount of water:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak-period consumptive use of the crop or crops to be irrigated.
2. The capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

**Outlets.** Appurtenances to deliver water from the pipe system to the land, to a ditch or reservoir, or to any surface pipe system shall be known as outlets. Outlets shall have adequate capacity at design working pressure to deliver the required flow to:

1. The hydraulic gradeline of a pipe or ditch,
2. A point at least 6 inch above the field surface, or
3. The design surface elevation in a reservoir.

**Stands open to the atmospheres.** Stands shall be placed at each inlet to the irrigation pipe system and at such other points as required. All stands shall serve as vents in addition to their other functions. Stands shall be constructed of steel pipe or other approved material and shall be supported on a base adequate to support the stand and prevent movement or undue stress on the pipeline. Open stands shall be designed to meet or exceed the following criteria:

1. Each stand shall allow at least 1 foot of freeboard above design working head. The stand height above the centerline of the pipeline shall be such that neither the static head nor the design plus freeboard shall exceed the allowable working pressure of the pipe.
2. The top of each stand shall extend at least 4 feet above the ground surface except for surface gravity inlets or where visibility is not a factor. Gravity inlets or stands shall be equipped with a trash guard.
3. Downward water velocities in stands shall not exceed 2 feet/second. The inside diameter of the stand shall not be less than the inside diameter of the pipeline. This downward velocity criterion applies only to stands having vertical offset inlets and outlets.
4. If the water velocity in the inlet (from the pump or other water source) equals or exceeds three times the velocity in the outlet pipeline, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.
5. The cross-sectional area of stands may be reduced above a point 1 foot above the top of the upper inlet or outlet pipe, but the reduced cross section shall not be such that it would produce an average velocity of more than 10 feet/second if the entire flow were discharging through it.
6. Vibration-control measures, such as special couplers or flexible pipe, shall be provided as needed to insure that vibration from pump discharge is not transmitted to stands.

Sand traps, when combined with a stand, shall have a minimum inside dimension of 30 inches and shall be constructed so that the bottom is at least 24 inches below the invert of the outlet to the pipeline. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 feet/second.

Gate stands shall be of sufficient dimensions to accommodate the gate or gates and shall be large enough to make the gates accessible for repair.

Float valve stands shall be large enough to provide accessibility for maintenance and to dampen surge.

**Vents.** Vents shall be designed into systems to provide for the removal and entry of air and protection from surge. They shall:

1. Have a minimum freeboard of 1 foot above the hydraulic gradeline. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum allowable working pressure of the pipe.
2. Have a cross-sectional area at least one-half the cross-sectional areas of the pipeline (both inside measurements) for a distance of at least one pipe diameter up from the centerline of the pipeline. Above this elevation the vent maybe reduced to 2 inch in a diameter. These cross-sectional requirements shall apply when an air-and-vacuum valve is used instead of a vent, but the reduced section shall be increased to the nominal size pipe required to fit the valve's threaded inlet. An acceptable alternative is

to install this valve in the side of a service outlet, provided that the riser is properly located and adequately sized.

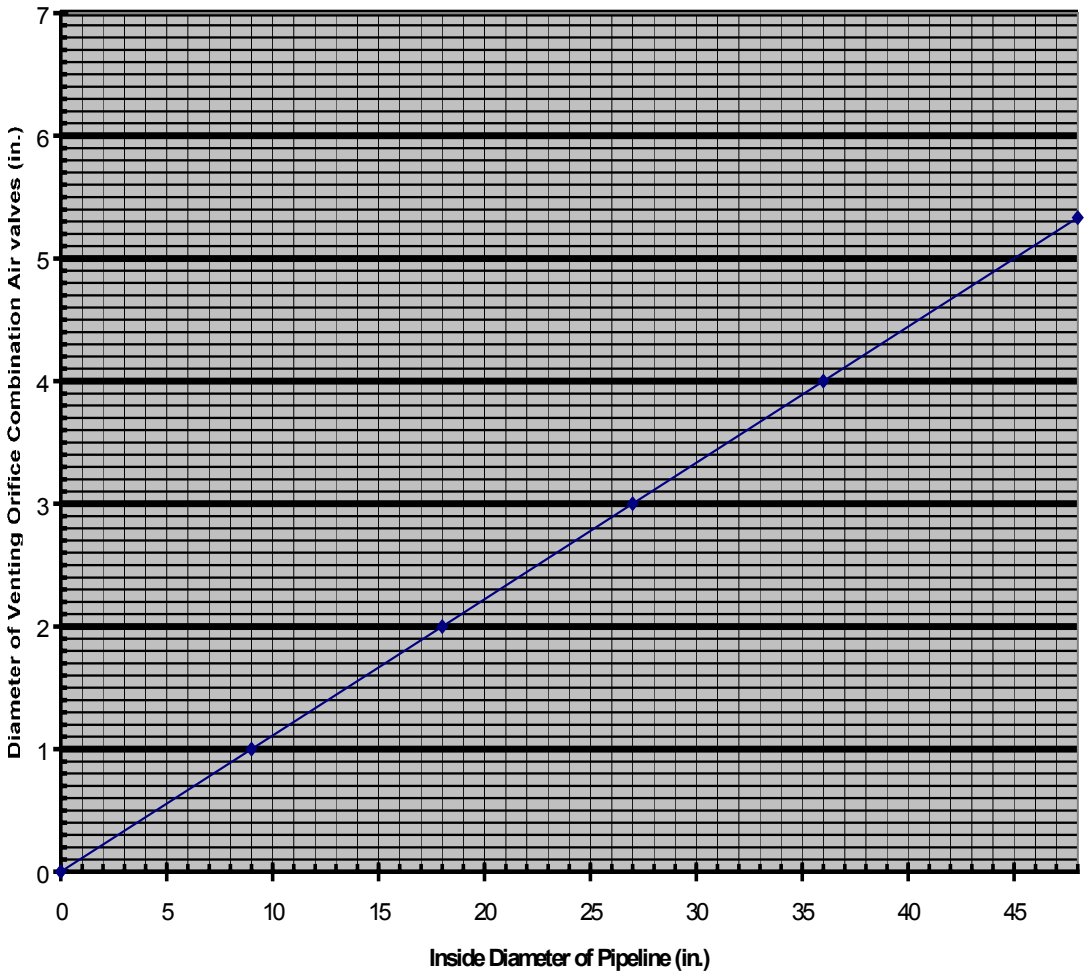
3. Be located at the downstream end of each lateral, at summits in the line, and at points where there are changes in grade in a downward direction of flow of more than 10 degrees.

**Combination air valve.** A combination air valve may be used instead of an open vent at summits and grade changes as listed under “Vents”.

The diameter of the orifice (opening that controls air-flow during filling and emptying operations) of and combination air valves shall equal or exceed that specified in Figure 1 for the appropriate diameter of the pipeline. The valve shall permit the escape of air from the pipeline while the line is working at design pressure.

Manufacturers of air-and-vacuum valves marketed for use under this standard shall provide dimensional data, which shall be the basis for selection and acceptance these valves.

**Figure 1. Sizing of Combination Air Valves**




**Check valves.** A check valve shall be installed between the pump discharge and the pipeline if detrimental backflow may occur.

**Drainage.** Provisions shall be made for completely draining the pipeline if a hazard is imposed by freezing temperatures or drainage of the line is desired. When drainage is required, drainage outlets shall be located at all low places in the line. These outlets may drain into dry wells or to points of lower elevation. If drainage

cannot be thus provided by gravity, provisions shall be made to empty the line by pumping or by other means.

**Flushing.** If provisions are needed for flushing the line free of sediment or other foreign material, a suitable valve shall be installed at the distal end of the pipeline.

**Thrust control.** Abrupt changes in pipeline grade or alignment, require either:

1. A stand having a diameter greater than that of the pipeline,
2. An anchor or thrust block to absorb any axial thrust of the pipeline, or
3. A larger diameter pipe placed horizontally or placed vertically and capped below ground or an in-line structure capped below ground.

An abrupt change shall be considered to be (a) an angle of 45 degrees or greater than the maximum working head is under 10 feet; (b) an angle of 30 degrees or greater when the maximum working head is between 10 and 20 feet; and (c) an angle of 15 degrees or greater when the maximum working head is greater than 20 feet.

Suitable thrust control shall be provided to resist end thrust of rubber gasket pipelines.

$$A = ((98\ HD^2)/B)\sin(a/2)$$

Where:

A = Area of thrust block required
H = Maximum working pressure in ft
D = Inside diameter of pipe in ft
B = Allowable passive pressure of the soil in $lb/ft^2$
a = Deflection angle of pipe bend

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90º deflection angle of pipe bend.

If adequate soil tests are not available, the passive soil pressure may be estimated from Table 1.

**Materials.** Concrete pipe shall equal or exceed the requirements of:

- Nonreinforced concrete irrigation pipe with rubber gaskets, ASTM C 505.
- Nonreinforced concrete irrigation pipe ASTM C 118.
- Concrete pipe stands larger than 24 inch in diameter shall meet the requirements of ASTM C 76 or C 478.

**Table 1 - Allowable Soil Bearing Pressure**

| Natural soil material | Depth of cover to center of thrust block | | | |
|---|---|---|---|---|
| | 2 ft | 3 ft | 4 ft | 5 ft |
| | ----------$lb/ft^2$---------- | | | |
| Sound bedrock | 8,000 | 10,000 | 10,000 | 10,000 |
| Dense sand and gravel mixture (assumed Ø = 40º) | 1,200 | 1,800 | 2,400 | 3,000 |
| Dense fine to coarse sand (assumed Ø = 35º) | 800 | 1,200 | 1,650 | 2,100 |
| Silt and clay mixture (assumed Ø = 25º) | 500 | 700 | 950 | 1,200 |
| Soft clay and organic soils (assumed Ø = 10º) | 200 | 300 | 400 | 500 |

**Joints and connections.** All joints and connections shall be designed to withstand the design maximum working pressure of the pipeline without leakage and leave the inside of the pipe free of obstruction that may tend to reduce its capacity. Fittings made of steel or other metal shall be protection from corrosion by a protective coating such as plastic tape wrap, coal tar-epoxy or other corrosion resistant coating.

**In-line valves.** In-line valves shall be equipped with geared operators.

**Draining and flushing.** Provisions shall be made for completely draining the pipeline where freezing is a hazard. As needed drains will be provided at low points along the pipeline or provisions shall be made to empty the pipeline by pumping.

**Fittings and Couplers.** All fittings and couplers shall meet or exceed the same strength requirements as those of the pipe and shall be of material that is recommended for use with the pipe.

**Depth of cover.** Pipe shall be installed at sufficient depth below ground surface to provide protection from hazards imposed by traffic crossings, farm crossings, farming operations, freezing temperatures or soil cracking. The minimum depth of cover for pipe susceptible to any of these hazards shall be 18 inches for pipelines 12 inch and less in diameter and 24 inches for pipe diameters larger than 12 inches.

At low places on the ground surface, extra fill may be placed over the pipeline to provide the minimum depth of cover. The top width of the fill shall be no less than 10 feet and the side slopes no steeper than 6:1.

**Trench.** The trench below the top of the pipe shall be only wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill material to be placed under the haunches of the pipe. The maximum trench width shall be 36 inches greater than the diameter of the pipe.

The trench bottom shall be uniform so that the entire length of the pipe has contact with soil without bridging. If rocks, boulders or any other material that can damage the pipe are encountered, the trench bottom shall be undercut a minimum of 6 inches below final grade and filled with bedding material.

**Backfill.** Hand, mechanical or water packing methods may be used.

The initial backfill shall be soil or sand that is free of rocks, gravels and clods larger than 2 inch in diameter.

**Final backfill.** The final backfill shall be free of large rocks, frozen clods and other debris larger than 3 inches in diameter.

All special backfill requirements of the pipe manufacturer shall be met.

**Testing.** The pipeline shall be tested for leakage and proper functioning. The tests may be performed before backfilling or anytime after the pipeline is ready for service.

**Certification and guarantee.** The installing contractor shall certify that his/her installation complies with the requirements of this standard. The Contractor shall furnish a written guarantee that protects the owner against defective workmanship and materials for a period of not less than 1 year. The certification shall identify the pipe manufacturer and markings on the pipe being supplied.

## CONSIDERATIONS

In soils subject to cracking and/or sloughing or the trench depth is 5 feet or greater include provisions for shoring or sloping sides of the trench.

Where differential settlement can create a concentrated loading on the pipe, as at the connection of a buried pipe to a rigid structure consider a flexible joint in the pipe adjacent to the structure.

Consider effects on the water budget, especially on volumes and rates of runoff to downstream water users.

Consider the effects on wetlands and water related wildlife.

Consider effects on water flows and aquifers and the affect to other water uses and users.

Consider the potential effect on irrigation water management.

## PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared to show site specifics. The drawings and specifications shall show pipe location, pipe type, pressure classes and sizes, details for appurtenances including type, pressure class (settings) size and locations, thrust block locations and sizes and trench/backfill requirements as applicable.

## OPERATION AND MAINTENANCE

The operation and maintenance of the system shall include typical items of flushing pipe, cleaning and repairing appurtenances etc.

## REFERENCES

- Engineering Field Manual

  Chapter 3, Hydraulics

  Chapter 15, Irrigation

- NRCS Conservation Practices

  Structure for Water Control, Code 587

  Irrigation System, Surface and Subsurface, Code 443

  Irrigation System, Tailwater Recovery, Code 447

- ASAE Standard

  ASAE S261.7, Design and Installation of Nonreinforced Concrete Irrigation Pipe Systems